

MEDICAL GAS PIPELINE & SOURCE SYSTEM
SPECIFICATIONS

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SECTION 1 – Medical Gas Pipeline Equipment for Healthcare Facilities

1 Automatic Medical Gas Manifolds:

1.1 General Requirements

- 1.1.1 The manifold shall be of a fully automatic type and shall switch from “Bank in Use” to “Reserve Bank” without fluctuation in the final line pressure.
- 1.1.2 After the switchover, the “Reserve Bank” shall then become the “Bank in Use” and the “Bank in Use” shall become the “Reserve Bank.”
- 1.1.3 The control panel includes a line gauge, two bank gauges and incorporates six LED’s: two green for “Bank in Use,” two yellow for “Bank Ready” and two red for “Bank Empty” on the front of the cabinet. These LEDs shall be noticeable when lit, even in poor lighting conditions.
- 1.1.4 The manifold shall be equipped with a 3/4" outlet shutoff valve. The valve comes complete with a 3/4" type “K” 6-3/4" long pipe extensions and 1/8" port for an optional pressure switch.
- 1.1.5 The header bars shall be equipped with *high* pressure shutoff valves outside the cabinet to allow for emergency isolation of the header bars. The header bar shall incorporate integral check valves for each station.
- 1.1.6 Input power to the manifolds is 110 to 240 VAC, 50-60 Hz.

1.2 Dome Loaded Manifold NFPA

- 1.2.1 The manifold shall have digital gauges.
- 1.2.2 The manifold shall consist of two bank regulators (dome bias) used to reduce the cylinder pressure to the two line regulators which in turn controls the final line pressure.
- 1.2.3 The manifold has an intermediate and line relief valve that is internally connected to a common vent port, terminating into a 1/2" FNPT pipe.
- 1.2.4 The header bars shall be equipped with *high* pressure shutoff valves outside the cabinet to allow for emergency isolation of the header bars. The header bar shall incorporate integral check valves for each station.
- 1.2.5 The manifold is equipped with pressure transducers, which sends information to the main circuit board for operation of the fail-safe relay which transmits a remote signal to the master alarm or buzzer.
- 1.2.6 The header bar mounting brackets are only supplied with more than 10 cylinders, for a staggered header bar, and more than 4 cylinders for a straight header bar.
- 1.2.7 The manifold cabinet is for general purpose use with an optional NEMA-3R enclosure for the power supply.
- 1.2.8 A “NEMA-4” enclosure must be used for outdoor use. The enclosure must be manufactured out of aluminum to prevent rusting of the enclosure. “NEMA-4” cabinets are designed to provide protection against dust, dirt, oil, and water.
- 1.2.9 Optional heaters are recommended for Nitrous Oxide and Carbon Dioxide manifolds.

- 1.2.10 It is not recommended to install the Carbon Dioxide or Nitrous Oxide manifold in an area with an ambient temperature below 32°F.
- 1.2.11 The external shut-off valves connecting to the header bars must be ball valves capable of withstanding pressure of 3,000 psi.
- 1.2.12 The manifold shall be installed in accordance with the requirements stated by NFPA 99, CGA, and all applicable local codes. It is recommended the control cabinet be located at an installation site protected from rain, snow and direct sunlight.
- 1.2.13 The manifold shall include a wall-mounting bracket.
- 1.2.14 A removable cabinet enclosure for easy installation and service is also provided with the manifold.
- 1.2.15 Flow capacity for Oxygen, Nitrous Oxide, Medical Air, and Carbon Dioxide shall exceed 4500 SCFH.
- 1.2.16 Flow capacity for Nitrogen shall be 6000 SCFH.
- 1.2.17 The manifold shall comply with NFPA 99.

2 EMERGENCY OXYGEN INLET STATIONS

2.1 General Requirements:

- 2.1.1 Emergency oxygen inlet stations shall comply with NFPA-99.
- 2.1.2 As required by NFPA-99, oxygen systems having the source of supply outside the building shall have an inlet to connect a temporary, auxiliary source of supply for emergency or maintenance situations. This connection shall include necessary valves and a high pressure regulator to allow for an emergency supply of oxygen and isolation of the normal source of supply.
- 2.1.3 The Emergency Gaseous Oxygen Inlet shall be housed in a weather tight recessed or surface mount enclosure. The interior of the enclosure shall be clearly labelled with instructions for connection and operation of the emergency oxygen inlet.
- 2.1.4 The enclosure door shall be labelled "Emergency Low Pressure Gaseous Oxygen Inlet" and shall be equipped with a staple for padlocking to allow entry only by authorized personnel.

2.2 Recessed Emergency Oxygen Inlet Stations (Low Pressure)

- 2.2.1 The inlet connection shall be a 1" female NPT connection and be provided with a plug to prevent entry of foreign matter into the oxygen system when not in use.
- 2.2.2 A 1" brass ball valve shall control access to the emergency supply, and the gauge indicates the pressure being introduced into the Oxygen pipeline.
- 2.2.3 The enclosure door shall be labelled "Emergency Low Pressure Gaseous Oxygen Inlet" and shall be equipped with a staple for padlocking to allow entry only by authorized personnel.

- 2.2.4 A mounting frame shall extend completely around the enclosure to trim recessed mounting on an exterior wall.
- 2.2.5 The box may be mounted horizontally or vertically by changing the front label.
- 2.2.6 The check valves shall be a 3-Piece design, with a removable body for servicing without cutting or disassembling of lines. Valves shall be provided with type-K copper extensions for connections on the pipeline. Required for installation in the main and emergency supply pipeline, in accordance with NFPA-99.
- 2.2.7 A brass body relief valve with the relief pressure set @75 psi is required for installation in the emergency supply line. The relief valve shall be supplied factory cleaned for Oxygen service and shall automatically reset after discharging to provide a positive seal.
- 2.2.8 All components will be sourced and cleaned for medical gas service. The sealing compound used will be compatible for medical gas service.

2.3 Recessed Emergency Oxygen Inlet Station (High Pressure)

- 2.3.1 The inlet connection shall only accept a CGA 540 connection and be provided with a nut to prevent entry of foreign matter into the Oxygen system when not in use.
- 2.3.2 A 1" brass ball valve and a high pressure regulator controls access to the emergency supply and indicates the supply pressure and the pressure being introduced into the Oxygen pipeline.
- 2.3.3 The enclosure door shall be labelled "Emergency High Pressure Gaseous Oxygen Inlet" and shall be equipped with a staple for padlocking to allow entry only by authorized personnel.
- 2.3.4 A mounting frame shall extend completely around the enclosure to trim recessed mounting on an exterior wall.
- 2.3.5 Bronze body check valves with female pipe threads on each end shall be provided for installation in the main and emergency supply pipeline in accordance with NFPA-99
- 2.3.6 A brass body relief valve with the relief pressure set @75 psi shall be provided for installation in the emergency supply line. The relief valve shall be supplied factory cleaned for oxygen service and shall automatically reset after discharging to provide a positive seal.
- 2.3.7 The unit shall have dual digital gauges for display of supply and delivery pressures.

2.4 Emergency Oxygen Inlet Station 2" (Recessed Low Pressure)

- 2.4.1 The inlet connection shall be a 2" female NPT connection and be provided with a plug to prevent entry of foreign matter into the oxygen system when not in use.
- 2.4.2 A 3-piece, threaded 2" bronze ball valve controls access to the emergency supply and the gauge indicates the pressure being introduced into the oxygen pipeline.

- 2.4.3 The enclosure door shall be labelled "Emergency Low Pressure Gaseous Oxygen Inlet" and shall be equipped with a staple for padlocking to allow entry only by authorized personnel.
- 2.4.4 A mounting frame shall extend completely around the enclosure to trim recessed mounting on an exterior wall.
- 2.4.5 The box may be mounted horizontally or vertically by changing the front label.
- 2.4.6 The brass check valves shall be a 3-piece design, with a removable body for servicing without cutting or disassembling of lines. Valves are to be provided with type-K copper extensions for connections on the pipeline, as required for installation in the main and emergency supply pipeline, in accordance with NFPA-99.
- 2.4.7 A brass body relief valve with the relief pressure set at 75 psi is required for installation in the emergency supply line. The relief valve shall be supplied factory cleaned for Oxygen service and shall automatically reset after discharging to provide a positive seal.
- 2.4.8 All components will be sourced and cleaned for medical gas service. The sealing compound used will be compatible with medical gas service.
- 2.4.9 The unit shall have a gauge for display of supply pressure.

2.5 Surface Mount Emergency Oxygen Inlet Station (Low Pressure)

- 2.5.1 The inlet connection shall be a 1" female NPT connection and be provided with a plug to prevent entry of foreign matter into the oxygen system when not in use.
- 2.5.2 A 1" brass ball valve controls access to the emergency supply, and the gauge indicates the pressure being introduced into the Oxygen pipeline.
- 2.5.3 Bronze body check valves with female pipe threads on each end shall be provided for installation in the main and emergency supply pipeline in accordance with NFPA-99
- 2.5.4 A brass body relief valve with the relief pressure set @75 psi shall be required for installation in the emergency supply line. The relief valve shall be supplied factory cleaned for oxygen service and shall automatically reset after discharging to provide a positive seal.
- 2.5.5 All components will be sourced and cleaned for medical gas service. The sealing compound used will be compatible with medical gas service.
- 2.5.6 The unit shall have a gauge for display of supply pressure.
- 2.5.7 The box may be mounted horizontally or vertically by changing the front label.

2.6 Surface Mount Emergency Oxygen Inlet Stations (High Pressure)

- 2.6.1 The inlet connection shall be a 1" female NPT connection and be provided with a plug to prevent entry of foreign matter into the oxygen system when not in use.
- 2.6.2 A 1" brass ball valve controls access to the emergency supply, and the gauge indicates the pressure being introduced into the oxygen pipeline.

- 2.6.3 Bronze body check valves with female pipe threads on each end shall be required for installation in the main and emergency supply pipeline in accordance with NFPA-99
- 2.6.4 A brass body relief valve with the relief pressure set @75 psi shall be required for installation in the emergency supply line. The relief valve shall be supplied factory cleaned for oxygen service and shall automatically reset after discharging to provide a positive seal.
- 2.6.5 The unit shall have a gauge for display of supply pressure.
- 2.6.6 The box may be mounted horizontally or vertically by changing the front label.

2.7 Emergency Oxygen Inlet Station 2" (Surface Mount Low Pressure)

- 2.7.1 The inlet connection shall be a 2" female NPT connection and be provided with a plug to prevent entry of foreign matter into the oxygen system when not in use.
- 2.7.2 A 3-piece, threaded 2" bronze ball valve controls access to the emergency supply and the gauge indicates the pressure being introduced into the Oxygen pipeline.
- 2.7.3 The enclosure door shall be labelled "Emergency Low Pressure Gaseous Oxygen Inlet" and shall be equipped with a staple for padlocking to allow entry only by authorized personnel.
- 2.7.4 The brass check valves shall be a 3-piece design, with a removable body for servicing without cutting or disassembling of lines. Valves are to be provided with type-K copper extensions for connections on the pipeline, as required for installation in the main and emergency supply pipeline, in accordance with NFPA-99.
- 2.7.5 A brass body relief valve with the relief pressure set at 75 psi is required for installation in the emergency supply line. The relief valve shall be supplied factory cleaned for Oxygen service and shall automatically reset after discharging to provide a positive seal.
- 2.7.6 All components will be sourced and cleaned for medical gas service. The sealing compound used will be compatible with medical gas service.
- 2.7.7 The unit shall have a gauge for display of supply pressure.
- 2.7.8 The box may be mounted horizontally or vertically by changing the front label.

3 DUAL LINE REGULATING STATIONS

3.1 Dual Line Regulating Station

- 3.1.1 The station shall comply with NFPA 99.
- 3.1.2 The station shall consist of ½" NPT threads, ½" isolation valves, a L700 Regulator, a bleed valve, a pressure gauge, a ½" relief valve.

4 HEADER BARS

4.1 General Requirements:

- 4.1.1 The header bars shall be equipped with emergency high pressure ball valve shutoff valves to allow for emergency isolation of the header bars. The header bar shall incorporate integral check valves for each station.
- 4.1.2 NOTE: The header bar shall come with universal mounting brackets to be mounted direct or with a 12" wall spacing when the optional wall mounting bracket is used.
- 4.1.3 All header bars and pigtails shall be cleaned for Oxygen service.
- 4.1.4 Header bars are Oxygen cleaned to include brass shut-off valves for high/low and liquid pressure gases. Configurations include Staggered, Straight, L-Shaped, U-Shaped and Vertical Cross Overs. Pigtails are available in standard sizes of 24" and 36", Brass and Stainless Steel.

4.2 Standard Header Bars

- 4.2.1 CGA gas specific header bar with an option to add integral check valves and cylinder pigtail assemblies for future expansion.
- 4.2.2 Standard header bar assemblies shall be configured so that cylinders inlets are on 11" centers.
- 4.2.3 The manifold shall be able to support, at maximum, a 5x5 staggered header bar.
- 4.2.4 The straight header bar shall contain a wall support bracket on every second pipe in between each cylinder.
- 4.2.5 The staggered header bar shall contain a wall support bracket in place after every 5 cylinders, unless additional support is required.

5 PIGTAILS

5.1 General Requirements:

- 5.1.1 Note: Burst pressure ratings for pigtails are determined at room temperature with the hose in a straight line. A safety factor of 4:1 shall be used for normal applications. Impulse and shock pressure applications may require a higher safety factor. Note: Do not apply heat to pigtails.
- 5.1.2 All cylinder connections shall be machined to CGA specifications for applicable gases.
- 5.1.3 Pigtails shall comply with NFPA 99
- 5.1.4 Pigtails shall share the following characteristics:
 - 5.1.4.1 The burst pressure rating at room temperature is 12,000 psig
 - 5.1.4.2 The maximum working pressure on the tubing is 3000 psig.

- 5.1.4.3 All pigtails are 100% tested before shipping and labelled for gas service and pressure rating.
- 5.1.4.4 Standard length 36" (3')
- 5.1.4.5 Includes a sticker that indicates the direction of the flow
- 5.1.4.6 For gases other than Oxygen and Helium, 36" stainless steel, flexible type pigtails are used. Oxygen and helium pigtails are rigid copper and are pre-bent to the approximate shape for connection the cylinders.

5.2 Coil Guard Pigtails

- 5.2.1 The *stainless steel pigtails* shall have a core which consists of Teflon (Polytetrafluoroethylene) with two outer reinforcing jackets of stainless steel braid. The braid will incorporate a type 304 full hard drawn stainless steel wire. It shall consist of a 1/4" nominal I.D. The stainless steel pigtails shall come with a check valve equipped to one of the ends.
- 5.2.2 Available for Air, Nitrogen, Carbon Dioxide and Nitrous Oxide.
- 5.2.3 The pigtails shall include a stainless steel coil guard.
*NOT TO BE USED FOR OXYGEN SERVICE

5.3 High Pressure Copper Pigtails

- 5.3.1 The copper pigtails shall have a 5/16" x 0.065" wall thickness, copper tube. The copper pigtails shall come with a check valve equipped to one of the ends.
- 5.3.2 Available for Nitrogen, Oxygen, Air, Carbon Dioxide and Nitrous Oxide.

5.4 High Pressure Stainless Steel Pigtails

- 5.4.1 The *stainless steel pigtails* shall have a core which consists of Teflon (Polytetrafluoroethylene) with two outer reinforcing jackets of stainless steel braid. The braid will incorporate a type 304 full hard drawn stainless steel wire. It shall consist of a 1/4" nominal I.D. The stainless steel pigtails shall come with a check valve equipped to one of the ends.
- 5.4.2 Available for Air, Nitrogen, Carbon Dioxide and Nitrous Oxide.

6 ISOLATION VALVES WITH PIPE STUB EXTENSIONS

6.1 General Requirements

- 6.1.1 The Valve shall be 3 piece ball-type design with a bronze body and chrome plated brass ball for sizes 1/2" to 2-1/2". Seats shall be Teflon (PTFE) and a Viton stem and flange O-

rings. A blow-out proof stem shall be used and the valve shall have a maximum pressure rating of 600 psi.

- 6.1.2 Ball valves shall be equipped with type "K" copper pipe stub extensions at both the inlet and outlet sides of the valve port to facilitate installation.
- 6.1.3 Valves shall be operated by a lever-type handle requiring only a quarter turn from a fully open position to a fully closed position.
- 6.1.4 Valves shall be designed in such a manner that it can be "swung-out" during installation so as to prevent damage due to heat transfer during the brazing operation.
- 6.1.5 Each valve assembly shall be washed and degreased for medical gas service. Pipe stub extensions shall be capped at both ends. The valve shall be supplied in a sealed plastic bag to prevent contamination prior to installation.
- 6.1.6 Valves shall be available in either locking or non-locking.
- 6.1.7 Valves shall have been 100% pressure tested.

6.2 Isolation Valves with Extensions and Single Gauge Port

- 6.2.1 Valves shall consist of a single gauge port.
- 6.2.2 Valves shall be available in sizes ½" to 2-1/2".

6.3 Isolation Valves with Extensions and Dual Gauge Port

- 6.3.1 Valves shall be consist of dual ports.
- 6.3.2 Valves shall be available in sizes ½" to 4".

7 ZONE VALVE BOXES:

7.1 General Requirements:

- 7.1.1 Zone Valve Boxes shall comply with NFPA 99
- 7.1.2 The valve box shall be constructed of 18 gauge steel, complete with a baked white enamel finish. Affixed to the opposite sides of the box will be two adjustable steel brackets for the purpose of mounting the box to the structural support. The steel brackets shall accommodate various finished wall thicknesses between 3/8" and 1-3/16" and shall be field adjustable.
- 7.1.3 The frame assembly shall be constructed of anodized aluminum and shall be mounted to the back box assembly by standard #6 x 3/8" tapping screws as provided.
- 7.1.4 With the exception of the security valve box, the removable front shall consist of an opaque window with a pullout ring pre-mounted to the center of the window.

- 7.1.5 With the exception of the security valve box, access to the zone shut-off valves shall be by merely pulling the ring assembly to remove the window from the frame. The window can be reinstalled without the use of tools only after the valve handles have been returned to the open position.
- 7.1.6 With the exception of the security valve box and the alarm/valve combination units, the window shall be marked to prohibit unauthorized persons from tampering with the valves with the following silk-screen caution: "MEDICAL GAS CONTROL VALVES. CLOSE ONLY IN EMERGENCY"
- 7.1.7 With the exception of the security valve box and the alarm/valve combination units, each valve shall be supplied with an identification bracket which shall be bolted directly onto the valve box for the purpose of applying an approved medical gas identification label. A package of labels shall be supplied with each valve box assembly for application by the installer.
- 7.1.8 The front panel shall be labelled to instruct persons to close the valves only in an emergency.
- 7.1.9 The valve box shall be constructed so that the front panel cannot be attached to the box while any valve inside is in the closed position.
- 7.1.10 Openings to the box's interior shall be dust-tight.
- 7.1.11 Each pipe inside the box shall come with its own pressure gauge that can be viewed through the clear window.
- 7.1.12 All gases and their respective gauges shall be clearly labelled with the proper color coordination as per NFPA 99.

7.2 Alarm Valve Combo Zone Valve Boxes

- 7.2.1 Input power to the alarm/valve combo units shall be 115 to 220 VAC, 50 to 60 Hz.
- 7.2.2 The alarm/valve combination units shall have dry contacts for remote monitoring of the high and low alarm.
- 7.2.3 Valves: Refer to section 7, and includes other details under each type of valve box. The valve characteristics in section 8 supersede section 7 when in conflict.
- 7.2.4 The single valve combination unit and the horizontal valve combination unit shall share the following features:
 - 7.2.4.1 The units shall have a 2 in 1 design that combines the Area Alarm and Zone Valve Box, to allow for space restrictions in the wall.
 - 7.2.4.2 Illuminated LED display shall be readable even in poor lighting conditions.
 - 7.2.4.3 High/low alarm set-points shall be field adjustable for each gas service.
 - 7.2.4.4 Repeat alarm shall be adjustable from 1 to 60 minutes or off.
 - 7.2.4.5 The combination unit shall have a gas-specific sensor with a DISS nut and a nipple.

- 7.2.4.6 The combination unit shall have an alarm buzzer in excess of 90 decibels.
- 7.2.4.7 Each module shall be marked with an approved medical gas identification label
- 7.2.4.8 Individual microprocessor for each display and sensor module digital sensor shall be mounted locally.
- 7.2.4.9 The combination unit shall have a set of dry contacts for remote monitoring of the high and low alarm.
- 7.2.4.10 Each valve shall be identified for gas specification as indicated on the hinged alarm label.
- 7.2.4.11 The window shall be marked to prohibit unauthorized persons from tampering with the valves with the following caution: "Medical Gas Control Valves with Alarms" "Close Valves Only in Emergency".
- 7.2.4.12 The digital alarm shall read from 0-250 PSI for pressure and 0-30"Hg for vacuum. The digital read-out shall provide a constant indication of each service being measured. It will indicate a green "NORMAL" and a red "HIGH" or "LOW" alarm condition. If an alarm occurs, the "RED" alarm light shall flash and the audible alarm (which exceeds 90 decibels) will sound. Pushing the "ALARM MUTE" button will cancel the audible alarm, but the unit will remain in the alarm condition until the problem is rectified.
- 7.2.4.13 A repeat alarm function shall, when enabled on the compact alarm module be capable of turning on the buzzer again (after a preset time) if the fault condition has not been rectified.
- 7.2.4.14 Each alarm module shall be individually microprocessor based and be field adjustable. The default set point on this alarm shall be +/- 20% variation from normal condition. In the calibration mode the following parameters shall be adjustable: High/Low set-points, Repeat alarm Enable/Disable (adjustable from 1 to 60 minutes). Set points shall be adjustable by two on-board push buttons.
- 7.2.4.15 The frame assembly shall be constructed of anodized aluminum and shall be mounted to the back box assembly by standard #6 x 3/8" tapping screws as provided.

7.3 Security Zone Valve Box Assembly:

- 7.3.1 Security Zone Valve Box Assembly shall comply with NFPA 99.
- 7.3.2 Each recessed zone valve box shall consist of the following components:
 - 7.3.2.1 A steel valve box which can house two to six chrome plated shut-off ball valves with tube extensions and a stainless steel door assembly.
- 7.3.3 The stainless steel door frame assembly shall be constructed of 14 gauge stainless steel and shall be mounted to the back box assembly by standard number 6-32 screws as provided. The door shall be spot-welded to the frame with a stainless steel hinge. Access to the box shall be by means of a lock and key.

- 7.3.4 The Valve shall be a 3 piece ball-type design with a bronze body and chrome plated brass ball for sizes 1/2" to 2-1/2". Seats shall be Teflon (TFE) and seals Viton for 1/2"-3". A blow-out proof stem shall be used and the valve shall have a maximum pressure rating of 600 PSI.
- 7.3.5 All valves shall be equipped with type "K" washed and degreased copper pipe stub extensions of sufficient length to protrude beyond the sides of the box.
- 7.3.6 The entire valve body and pipe stubs shall be chrome plated to a minimum of 1" beyond the sides of the back box, but in no instance shall the chrome plating be extended to the ends of the pipe stubs.
- 7.3.7 All pipe stub extensions shall be supplied with suitable plugs or caps to prevent contamination of the assembly prior to installation.
- 7.3.8 Each valve shall be supplied with an identification bracket which shall be bolted directly onto the valve box for the purpose of applying an approved medical gas identification label. A package of labels shall be supplied with each valve box assembly for application by the installer.

7.4 Sensor Valve Combo Unit:

- 7.4.1 Each recessed zone valve box shall consist of the following components:
 - 7.4.1.1 A steel valve box which can house one to seven shut-off ball valves with tube extensions, an aluminum frame and a pull-out removable window. Gauge options are 100 PSI, 300 PSI or 30 in Hg. Terminal strips are provided with the box. The sensors and DISS fittings are gas specific, and provided with the alarm.
- 7.4.2 The frame assembly shall be constructed of anodized aluminum and shall be mounted to the back box assembly by standard #6 * 3/8" tapping screws provided. The removable front shall consist of an opaque window with a pull-out ring pre-mounted to the center of the window.
- 7.4.3 Access to the zone shut-off valves shall be by merely pulling the ring assembly to remove the window from the frame. The window can be reinstalled without the use of tools only after the valve handles have been returned to the open position.
- 7.4.4 The window shall be marked to prohibit unauthorized persons from tampering with the valves with the following silk-screen caution: "MEDICAL GAS CONTROL VALVES. CLOSE ONLY IN EMERGENCY"
- 7.4.5 The valve shall be a 3 piece, ball-type design with a brass forging body and a chrome plated brass ball for sizes 1/2" to 2". Seats shall be reinforced Teflon (PTFE) with Viton seals for 1/2"-2".
- 7.4.6 Pipe stub extensions shall have dual gauge ports. One 1/8" NPT elbow shall be provided per valve.

- 7.4.7 All pipe stub extensions shall be supplied with suitable plugs or caps to prevent contamination of the assembly prior to installation.

7.5 Multiple Zone Valve Box:

- 7.5.1 Each recessed zone valve box shall consist of the following components: A steel valve box which can house two to seven shut-off ball valves with tube extensions, an aluminum frame and a pull-out removable window. Gauges shall be provided for each Zone Valve housed.
- 7.5.2 The frame assembly shall be constructed of anodized aluminum and shall be mounted to the back box assembly by standard #6 *3/8" tapping screws as provided.
- 7.5.3 The removable front shall consist of a window with a pull-out ring pre-mounted to the center of the window.
- 7.5.4 The valve shall be 3 piece, ball-type design with a brass forging body and a chrome plated, and brass ball for sizes 1/2" to 2". Ball seats, stem seals and stem washer shall be reinforced Teflon (PTFE), with Viton stem and flange O-rings.
- 7.5.5 All valve materials shall be compatible with medical gases or vacuum service to 29" Hg.

7.6 Single Zone Valve Box:

- 7.6.1 Each recessed zone valve box shall consist of the following components: A steel valve box which can house one shut-off ball valve with tube extensions, an aluminum frame, and a pull-out removable opaque window. Gauges are included.
- 7.6.2 The frame assembly shall be constructed of anodized aluminum and shall be mounted to the back box assembly by standard number 6/32" x 3/8" tapping screws as provided.
- 7.6.3 The removable front shall be an opaque window with a pull-out ring pre-mounted to the center of the window.
- 7.6.4 The valve shall be a 3 piece ball-type design with a brass forging body and a chrome plated brass ball for sizes 1 / 2" to 3". Ball seats, stem seals and stem washer shall be reinforced Teflon (PTFE), with Viton stem and flange O-rings.
- 7.6.5 All valve materials shall be compatible with medical gases or vacuum service to 29" Hg.

8 MEDICAL GAS OUTLETS:

8.1 General Requirements:

- 8.1.1 All outlets shall comply with NFPA 99 and Outlet flow rates shall exceed these requirements.

- 8.1.2 Outlets shall be UL Listed or ETL Listed.
- 8.1.3 A large, color coded front plate shall be used for ease of gas identification and aesthetic appeal.
- 8.1.4 Outlets shall come in one of the following connection styles:
 - 8.1.4.1 Ohmeda
 - 8.1.4.2 DISS
 - 8.1.4.3 Chemetron
 - 8.1.4.4 Puritan-Bennet
 - 8.1.4.5 Oxequip/Medstar (except ceiling outlets)
- 8.1.5 The latch-valve assembly shall be compatible with one of the connection styles in sentence 9.1.4 and shall only accept corresponding gas specific adapters with that connection style.
- 8.1.6 Outlets shall include a universal rough-in assembly in order to accept quick disconnects or DISS front adapters. They shall also be interchangeable at any time.
- 8.1.7 Outlets shall be of modular design and include a gas specific 16 ga. steel mounting plate designed to permit on-site ganging of multiple outlets, in any order, on 5" spacing.
- 8.1.8 Outlet bodies shall be gas specific by indexing each gas service to a gas specific out pin indexing arrangement on the respective identification module.
- 8.1.9 Each outlet shall be 100% pressure tested and cleaned for medical gas service.
- 8.1.10 Nitrogen and Instrument Air outlets shall use a DISS-style connection only.
- 8.1.11 MRI Outlets shall be manufactured from non-ferrous materials.
- 8.1.12 All outlets shall be cleaned and degreased for medical gas service, factory assembled and tested.
- 8.1.13 Outlets shall have double seals to prevent gas leakage
- 8.1.14 Outlets shall be manufactured with a 7-3/4" length type "K" 1/2" outside diameter (3/8" nominal) size copper inlet pipe stub which is silver brazed to the outlet body. The body shall be of 1-5/16" diameter, one piece brass construction.
- 8.1.15 For positive pressure gas services, the outlets shall be equipped with a primary and secondary check valve and the secondary check valve shall be rated at a maximum of 200 psi in the event the primary check valve is removed for maintenance.

8.2 Wall and Ceiling Outlets:

- 8.2.1 A one-piece chrome or satin fascia plate shall frame the outlet.
- 8.2.2 Wall outlets shall adjust from 3/8" up to 1" variation in wall thickness.
- 8.2.3 Outlets shall be of modular design and include a gas specific 16 ga. steel mounting plate designed to permit on-site ganging of multiple outlets, in any order, on 5" spacing.
- 8.2.4 360° Swivel Inlet Pipe is designed for easy installation

8.3 Console outlets:

- 8.3.1 With the back rough-in mounted, the outlet shall adjust up to $\frac{3}{4}$ " variation in mounting plate thickness.
- 8.3.2 360° Swivel Inlet Pipe is designed for easy installation

8.4 Ceiling Column Outlets:

- 8.4.1 With the back rough-in mounted, the outlet shall adjust up to $\frac{3}{4}$ " variation in mounting plate thickness.

8.5 Extended Latch Valve Assemblies:

- 8.5.1 Extended latch-valve assemblies shall accommodate a $\frac{3}{4}$ " to 1- $\frac{1}{4}$ " wall thickness.

9 AREA ALARM PANELS:

9.1 General Requirements:

- 9.1.1 Area alarms shall comply with NFPA 99.
- 9.1.2 Area alarms shall come with a five-year parts warranty.
- 9.1.3 Area alarms shall consist of multiple sensors, gauges, indicators, and a display.
- 9.1.4 Input power to the area alarm shall be 115-220 V, 50-60 Hz.
- 9.1.5 Sensors for area alarms may be either locally mounted or remotely mounted.
- 9.1.6 Each sensor unit is gas specific, with an error message display for an incorrect connection.
- 9.1.7 Each gas service shall be provided with a digital read-out comprising of 0-249 psi for pressure and 0-30"Hg for vacuum. The digital read-out shall provide a constant indication of each service being measured. It will indicate a green "NORMAL" and a red "HIGH" or "LOW" alarm condition.
- 9.1.8 If an alarm occurs, the green indicator shall change to red and a continuous audible alarm will sound. Pushing the mute button will cancel the audible alarm, but the unit will remain in the alarm condition until the problem is rectified.
- 9.1.9 The default set-points shall be +/- 20% variation from normal condition. In the calibration mode High/Low set-points shall be adjustable.
- 9.1.10 Area alarms shall have a self-diagnostic and error message display for ease of maintenance.

9.2 LED Compact Area Alarms:

- 10.2.1 The alarm shall have digital sensors that can be mounted locally or remotely utilizing twisted pair wiring up to 2500 ft.
- 10.2.2 The red indicator shall flash when an alarm occurs.
- 10.2.3 The high/low alarm set-points shall be field adjustable for each gas service
- 10.2.4 The unit shall have a repeat alarm, adjustable 1 to 60 minutes or off
- 10.2.5 The unit shall have a gas specific sensor with DISS nut and nipple. Display module with an error message for incorrect sensor to display connection
- 10.2.6 The unit shall have up to 12 gases in a standard configuration
- 10.2.7 The alarm shall have a volume of over 90 decibels
- 10.2.8 There shall be an individual microprocessor for each display and sensor module
- 10.2.9 All modules shall be mounted on a hinged frame for easy accessibility
- 10.2.10 The alarm shall have dry contacts for remote monitoring of high and low alarms and the distance between the master module and source equipment can be up to 5,000 ft.
- 10.2.11 The box shall be fabricated from 18 gauge steel with a 1/4" I.D. type "K" copper pipe for connection to the service line.
- 10.2.12 The default set point on the alarm shall be +/-20% variation from normal condition. In the calibration mode the following parameters shall be field adjustable: High/Low set-points, Repeat alarm Enable/Disable. Set points shall be adjustable by two on board push buttons.

9.3 LCD Area Alarms:

- 9.3.1 The alarm shall be microprocessor based with a 10" screen and capable of monitoring up to 8 sensors. Sensors shall be mounted locally (in the rough-in box) by installing the copper pipe provided or mounted remotely. Sensors will be automated for gas specific detection.
- 9.3.2 Area alarm shall be fabricated from 18 gauge steel with a 3/8" O.D. type "K" copper pipe for connection to the service line.
- 9.3.3 The default set-points shall be +/- 20% variation from normal condition. In the calibration mode High/Low set-points shall be adjustable by on board push buttons. To view the set points and audible alarm sound level, press and hold the mute button for twenty (20) seconds.
- 9.3.4 The digital sensors can be mounted locally or remotely utilizing shielded twisted pair wiring up to 500 ft.

- 9.3.5 The sensors shall be designed to create interference barrier for increased RFI/EMI protection.
- 9.3.6 The LCD brightness and volume shall be field adjustable.
- 9.3.7 The LCD display shall be readable in poor lighting conditions.
- 9.3.8 Screen text shall be customizable for gas locations.
- 9.3.9 The sensors shall be gas specific with a DISS nut and a nipple.
- 9.3.10 The LCD sensors' operating range shall be the following:
 - 9.3.10.1 Mid-pressure: 0-99 psi; Oxygen, AIR, Nitrous Oxide, and Carbon Dioxide.
 - 9.3.10.2 High-pressure: 0-249 psi; Instrument Air, and Nitrogen.
 - 9.3.10.3 Vacuum: 0-30" Hg; Vacuum, and Waste Anesthetic Gas Disposal.
- 9.3.11 The alarm shall conform to UL Standard 1069
- 9.3.12 The alarm shall comply with the electromagnetic compatibility standards FCC Part 15 Class A and ICES-003 Class A.

9.4 LCD Ethernet Area Alarms:

- 9.4.1 The alarm shall be microprocessor based with a 10" screen and capable of monitoring up to 8 sensors. Sensors shall be mounted locally (in the rough-in box) by installing the copper pipe provided or mounted remotely. Sensors will be automated for gas specific detection.
- 9.4.2 Ethernet LCD capable area alarms shall have the following functions:
 - 9.4.2.1 Display an exact replica of the alarm on a computer screen via the facility's Ethernet or internet. In addition, an exact image of the alarm shall be able to be displayed on a mobile device via Wi-Fi or mobile network.
 - 9.4.2.2 The image of the alarm that is transmitted shall update every second.
- 9.4.3 The default set-points shall be +/- 20% variation from normal condition. In the calibration mode, High/Low set points shall be adjustable by setup button and selecting set points with up and down buttons. The set points shall be viewed by pressing and holding the mute button for twenty (20) seconds.
- 9.4.4 Area alarm shall be fabricated from 18 gauge steel with a 3/8" O.D. type "K" copper pipe for connection to the service line.
- 9.4.5 The alarm shall comply with NFPA 99.
- 9.4.6 LCD Ethernet Alarms shall be able to email and text message alarm conditions instantly to 5 different addresses/phone numbers.

10 MASTER ALARM PANELS:

10.1 General Requirements:

- 10.1.1 Master alarms shall comply with NFPA 99.
- 10.1.2 Input power to master alarms shall be 115-220 V, 50-60 Hz.
- 10.1.3 Master alarms shall come with a 5-year warranty.

10.2 LED Master Alarms:

- 10.2.1 The master alarm shall comply with NFPA 99. The master alarm shall also be UL-listed.
- 10.2.2 The master alarm shall be microprocessor-based and field-adjustable.
- 10.2.3 Each signal contains a green LED indicator for normal and a red LED indicator for abnormal conditions.
- 10.2.4 When a fault occurs, the green LED shall turn off and the red LED shall illuminate, and the audible alarm shall sound. The red LED shall flash until the front panel alarm mute button is pressed. After the alarm mute button is pressed, the red LED shall remain illuminated without flashing. The red indicator shall automatically turn off and the green LED shall illuminate when the fault is corrected. A repeat alarm function shall, when enabled, be capable of turning on the buzzer again after a preset time, if the fault condition has not been rectified.
- 10.2.5 The master alarm shall be capable of accommodating up to 60 points. Each module shall accommodate 10 points and a total of 6 modules can be accommodated per standard box. Master alarms shall also be modular in construction and be capable of adding extra modules in the field.
- 10.2.6 Repeat alarm function shall, when enabled, be capable of turning on the buzzer again after a preset time, if the fault condition has not been rectified.
- 10.2.7 The Alarm shall be a closed circuit self-monitoring type. A green "POWER" light shall provide indication that the unit is energized. In addition "TEST" and "ALARM MUTE" buttons shall be easily accessible to operate and test the unit.
- 10.2.8 Every module shall be field upgradable to allow for interfacing to a building management system with the addition of an add-on circuit board which plugs into the master module.
- 10.2.9 The box shall be fabricated from 18 gauge steel and the box mounting brackets shall be adjustable to accommodate for different thickness of the wall.
- 10.2.10 A maintenance mode shall, when enabled, latch the alarms, requiring a reset after the alarm condition has been rectified. The master alarm shall identify the last alarm condition by flashing, while the already acknowledged alarm shows a continuous red signal.

10.3 LCD Ethernet Master Alarms:

- 10.3.1 The master alarm shall have a 10" LCD display.
- 10.3.2 The master alarm shall be capable of accommodating up to 30 points.
- 10.3.3 The master alarm shall comply with NFPA 99.
- 10.3.4 The master alarm shall be microprocessor-based and field-adjustable.
- 10.3.5 The master alarm shall be Ethernet ready, for Internet Explorer and Google Chrome.
- 10.3.6 The master alarm shall have a dry contact for remote viewing.
- 10.3.7 Master alarms shall be capable of the following:
 - 10.3.7.1 Display an exact replica of the alarm on a computer screen via the facility's Ethernet or internet. In addition, an exact image of the alarm shall be able to be displayed on a mobile device via Wi-Fi/mobile network/text message/SMS Messaging.
 - 10.3.7.2 The image of the alarm that is transmitted shall update every second.
- 10.3.8 When a channel is in normal condition, the channel shall illuminate in green. When a channel is in fault condition, an alarm shall sound and both the channel heading and the channel in fault shall illuminate in red. Heading shall display channel status in fault.
- 10.3.9 Repeat alarm function shall be capable of turning on the buzzer again after a preset time, if the fault condition has not been rectified.
- 10.3.10 Using Master Configuration Software, channels can be grouped together or separated.
- 10.3.11 Each channel shall be labelled with up to 16 characters per line. Alarm conditions shall be selected as normally open or normally closed.
- 10.3.12 The alarm shall be able to enter maintenance mode for easy troubleshooting. The display shall show the terminal port for each channel after pressing and holding the mute button for 20 seconds.

11 GAS CONTROL PANELS

11.1 General Requirements

- 11.1.1 Control panels shall have outlets that shall be used for connection to pneumatic surgical tools.
- 11.1.2 Control Panels shall be factory tested for intended gas service.

11.2 Compact Gas Control Panels

- 12.1.1 The control panel shall consist of carbon steel coated plate, pressure regulator, inlet pressure indicator, DISS outlet adapter, gas specific lamacoid and have ¼" internal copper tubing.
- 12.1.2 The DISS outlet shall be Diameter Index Safety System (D.I.S.S.) for an Air or Nitrogen service outlet or "Safety Swing Coupling" for pressure above 200 psig.
- 12.1.3 The plate shall include a color coded label to indicate which gas the control panel was designed for.
- 12.1.4 The unit shall be factory tested and cleaned for intended gas service.
- 12.1.5 The unit shall comply with NFPA 99.
- 12.1.6 Inlet pressure display gauge shall be in PSI
- 12.1.7 Maximum supply pressure shall be 250 PSI
- 12.1.8 Maximum delivery pressure:
- 12.1.9 The maximum delivery pressures for each gas shall be as follows:
 - 12.1.9.1 DISS: AIR, Carbon Dioxide = 80 PSI
 - 12.1.9.2 Nitrogen, Instrument Air = 200 PSI
 - 12.1.9.3 High Pressure Safety Swing Coupling = 250 PSI

12 PRESSURE REGULATORS

12.1 General Purpose Regulator

- 12.1.1 The regulator shall be panel mountable
- 12.1.2 The regulator shall be cleaned for medical gas service
- 12.1.3 The regulator shall contain the following:
 - 12.1.3.1.1 2 gauge ports measuring ¼" each.
 - 12.1.3.1.2 2 port threads, 1 measuring ¼" and the other measuring ½".
- 12.1.4 The regulator shall have a temperature rating of 40 F to 150 F.
- 12.1.5 The regulator shall have a high flow of 80 SCFM at the ¼" port thread, and 100 SCFM at the ½" port thread.
- 12.1.6 The regulator's capacity shall be 300 psi.
- 12.1.7 The regulator shall consist of the following materials:
 - 12.1.7.1 Adjusting knob: acetal
 - 12.1.7.2 Body: zinc
 - 12.1.7.3 Bottom plug: brass
 - 12.1.7.4 Elastomers: buna N
 - 12.1.7.5 Spring case: acetal

12.2 General Purpose Regulator Assembly

- 12.2.1 The regulator shall provide medical gas delivery pressure control to surgical tools or apparatus.
- 12.2.2 The regulator shall be cleaned for medical gas service.
- 12.2.3 The regulator shall contain the following:
 - 12.2.3.1 2 gauge ports measuring ¼" each.
 - 12.2.3.2 2 port threads, 1 measuring ¼" and the other measuring ½".
- 12.2.4 The regulator shall have a temperature rating of 40 F to 125 F.
- 12.2.5 The regulator shall have a high flow of 80 SCFM at the ¼" port thread, and 100 SCFM at the ½" port thread.
- 12.2.6 The regulator shall consist of the following materials:
 - 12.2.6.1 Adjusting knob: acetal
 - 12.2.6.2 Body: zinc
 - 12.2.6.3 Bottom plug: brass
 - 12.2.6.4 Elastomers: buna N
 - 12.2.6.5 Spring case: acetal
- 12.2.7 The regulator shall have a self-relieving type pressure regulator with a range of between 10 to 250 psig.
- 12.2.8 Control knob shall assist in the regulator's adjustment
- 12.2.9 The pressure gauge shall read between 0 and 300 psig, and have a diameter of 1-1/2".

12.3 Regulator Assembly

- 12.3.1 The assembly shall provide medical gas delivery pressure control to surgical tools or apparatus.
- 12.3.2 The assembly shall be cleaned for medical gas service.
- 12.3.3 The regulator body shall be made of zinc and die cast. The fittings shall be made of chrome-plated brass.
- 12.3.4 The assembly shall contain a self-relieving type pressure regulator with a 10 to 125 psig range
- 12.3.5 The control knob shall assist in the regulator's adjustment.
- 12.3.6 The pressure gauge shall read between 0 and 300 psig, and have a diameter of 1-1/2".

12.4 High Flow Regulator

- 12.4.1 The regulator shall consist of the following materials:
 - 12.4.1.1 Body: forged brass
 - 12.4.1.2 Diaphragm: neoprene

- 12.4.1.3 Housing cap: forged brass
- 12.4.2 The regulator shall come with a ½" NPT(F)
- 12.4.3 The regulator shall have a maximum inlet pressure of 350 psig.
- 12.4.4 The delivery range shall be between 10 to 200 psig.
- 12.4.5 The design shall be a forged brass body and housing cap.
- 12.4.6 The gauge shall be sized 2-1/2", if the gauge is included.
- 12.4.7 The regulator shall have a stem type seat mechanism
- 12.4.8 The diaphragm of the regulator shall be 3-1/4"
- 12.4.9 The regulator shall have a delrin cap bushing, intended for smooth adjustments
- 12.4.10 The regulator shall be for a line supply, of a single stage and extra heavy duty type.

SECTION 2 - Vacuum Equipment for Healthcare Facilities

1 GENERAL

- 1.1. Provide a complete medical vacuum source, complying with NFPA 99 5.1.3.6 in all respects, as specified and scheduled on the drawings.
- 1.2. The complete package will contain (#) (contactless claw/dry rotary vane/ lubricated rotary vane) vacuum pump(s), (1) ASME air receiver and (1) control panel, along with the associated equipment and piping. The unit will be able to meet the required demand with (1) pump out of operation. All capacities are to be indicated in SCFM @ 19 inHg.
 - 1.2.1. Each pump shall have a built-in anti-suck-back valve mounted at the pump inlet.
 - 1.2.2. Each pump shall be equipped with one pump isolation ball valve, one inlet check valve, one inlet stainless steel flex connector and one discharge stainless steel connector.

Specifier: If Bacterial Filters are to be included on the vacuum plant, please also include Option 1.2.3 below.

- 1.2.3. (1) Bacterial removal inlet filter per pump. The bacterial filter shall meet the requirements of the DHSS for infectious disease units with complete bacterial removal to 99.97% @ 0.1 micron.
 - 1.2.3.1. The bacterial filter will be designed for the removal of liquids, solids, and sub-micron particles. It will be rated for ULPA or UL media to the least.
 - 1.2.3.2. The bacterial filter will come equipped with a pressure drop indicator gauge, providing visual status of when the element should be replaced. Elements should be replaced no more frequent than twice on an annual basis, depending on usage.
 - 1.2.3.3. The bacterial filter will come equipped with brass valves and fittings for contaminated liquid release.
 - 1.2.3.4. The bacterial filter will have an easy removable and sterilizable glass flask.
 - 1.2.3.5. The bacterial filter will come with a high-impact and shatter resistance see-through bucket.
- 1.3. For maintenance and ventilation of the system, there shall be 2 ft. minimum clearance on all sides, and 3 ft. in front of the control panel.
- 1.4. This furnished and installed unit will be a standard catalog item of the MGEM, who is regularly engaged (minimum five years of experience) in the business of providing packaged systems for hospitals and facilities.
- 1.5. The furnished and installed medical vacuum system will meet or exceed the requirements of NFPA 99's most recent edition as relevant to the equipment; it will be extensively tested before shipment.

- 1.6. The unit will supply medical vacuum continuously for the life of the equipment. All components must be at least duplexed and valved (or check valved as provided in NFPA 99) to permit service to any component during maintenance operation or any condition of single fault failure, without interrupting vacuum supply to the facility.
- 1.7. The system will be completely factory assembled, requiring only interconnection between modules on site if necessary (will depend on configuration). Systems requiring site assembly other than interconnection between modules are not acceptable. However, the remounting of components detached for shipping is permitted.
 - 1.7.1. Each module will be sized to fit within the standard 36 in doorway on a standard pallet jack.
 - 1.7.2. System shall be tank mounted or built entirely on a single base or a base which can be separated (into modules) in the field for rigging. If separable, bases shall be prepared for separation at the factory.
 - 1.7.3. System shall be completely factory assembled having field connections limited to (1) inlet line, (1) electrical conduit and power, and exhaust equal to the amount of pumps.
 - 1.7.3.1. A single point of connection to the intake of the system shall be provided.
 - 1.7.3.2. A single point of connection to the electrical panel of the system shall also be provided.
 - 1.7.4. Systems requiring site assembly, other than interconnection between modules or reattachment of sections separated on site at contractor's convenience, are not acceptable. Thus, the remounting of components detached for shipping is permitted.
- 1.8. The system intake, and power connection at the control panel will be a single point connections. Exhaust will be connected to each pump.
- 1.9. All interconnecting piping and wiring shall be completed and operationally tested prior to shipment.
- 1.10. Liquid tight conduit, fittings, and junction boxes for all control and power wiring will be provided by the MGEM.
- 1.11. System base, frames, control cabinet and receiver shall all be powder coated for durable and attractive finish.

2 SYSTEM COMPONENTS

- 2.1. The control panel and all associated components will be built, labelled, and listed in a UL 508A certified panel shop. It will have a NEMA 12 enclosure, and abide by the following requirements.
 - 2.1.1. Provide in the control cabinet door, the following:

- 2.1.1.1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control. All monitoring must be done on a single screen, multiple screens are not acceptable.
- 2.1.1.2. 320 x 240 p;
- 2.1.1.3. A separate disconnect handle with door interlock for each pump unit.
- 2.1.1.4. Audio sounder capable of 90 dB at 3 ft., with noise reduction and mute function available on the door.
- 2.1.1.5. LED run indicators on H-O-A switches, indicating which pump is running.
- 2.1.2. Provide in the control cabinet interior, the following:
 - 2.1.2.1. Externally operable circuit breakers with door interlocks, control circuit transformers with fused primary and secondary circuits, H-O-A switches and magnetic starters with **three** leg overload protection.
 - 2.1.2.2. Full voltage motor starters with overload protection – one per pump unit.
 - 2.1.2.3. Alarm contacts must be provided for remote annunciation for all alarm points.
 - 2.1.2.4. Circuit breaker disconnects, one for each pump unit operated through the door disconnect handle.
 - 2.1.2.5. Controls circuitry shall be 120 Volts AC and 24 Volts DC.
 - 2.1.2.6. Redundant 120 Volts AC control circuit transformers including power seeking function in the event one power supply fails.
 - 2.1.2.7. Power distribution terminal block convenient for main power entry.
 - 2.1.2.8. All internal components needed for operation of the control system as described below.
 - 2.1.2.8.1. Volt free contacts for connection to master alarms.
 - 2.1.2.8.2. No proprietary controls and/or circuitry boards are to be present – all components readily available from local and standard electrical suppliers.
- 2.1.3. The control panel shall provide for the following functions:
 - 2.1.3.1. The reserve pump(s) must be able to start automatically if the lead pump fails to operate.
 - 2.1.3.2. Audible and visual local alarms are for pump temperature malfunction, reserve pump in use.
 - 2.1.3.3. Display of vacuum level on a single 'home' screen display for at-a-glance checking.
 - 2.1.3.4. Automatic lead/lag sequencing and alternation. Display shall clearly show status of each pump unit including the running unit, next-unit-in-sequence, and units unavailable to run.
 - 2.1.3.5. Manual reset for thermal malfunction shutdown.
 - 2.1.3.6. Runtime for each pump unit.

- 2.1.3.7. In the event of control failure the system shall activate all alarms and operate all pumps until repaired.
 - 2.1.3.8. When H-O-A selectors are in Auto mode, system shall operate on programmable logic controller.
 - 2.1.3.9. Controls shall provide visual and audible alarm indication and isolated contacts for remote alarm for at least Low Vacuum Level, Lag Pump in Use, and High Temperature for each pump unit.
 - 2.1.3.10. Controls shall provide automatic indication of major maintenance intervals.
 - 2.1.3.11. Controls shall provide distinct separate indication on the control screen of alarms related pump versus alarms related to the system.
 - 2.1.3.12. Alarm shall be stated on the main screen in plain language of the nature of the alarm. Labeled indication light are not permitted
 - 2.1.3.13. Controls shall provide isolated dry contacts for remote alarms required by NFPA 99 Section 5.1.9 related to Medical Vacuum Pump System
 - 2.1.3.14. Control system shall log and allow review of all alarm and shutdown events.
 - 2.1.3.15. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to deliver vacuum required. Control systems which can result in inability to deliver vacuum required in event of failure of any single component are not acceptable.
 - 2.1.3.16. All control and alarm functions must remain energized while any pump in the system remains electrically online.
 - 2.1.3.17. Controls shall include an integral webserver using standard Ethernet allowing observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special or additional separate software are not acceptable.
 - 2.1.3.18. Language selection options should include English, French, or Spanish.
 - 2.1.3.19. Email alert feature for any and all alarms must be available.
- 2.2. The vacuum receiver shall be as follows:
- 2.2.1. Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2.2.2. Interior Finish: ASME construction of ferrous and/or non-ferrous materials. Corrosion-resistant coating: ASME Boiler and Pressure Vessel Code Section VIII Division 1 construction with two-part epoxy lined coating providing rust protection that is equal to or better than what is normally achieved through galvanizing.
 - 2.2.3. Pressure Rating: Rated for a maximum 200 PSIG MAWP @ 400°F, and full vacuum service; capable of withstanding 29.9 inHg gauge.

- 2.2.4. Accessories: Equipped with manual valve drain, a source shut off valve, and a means for bypassing the receiver (isolation valve) to allow for repair and maintenance.
- 2.2.5. The tank isolation valve will allow for draining of the receiver without interrupting the vacuum service.
- 2.2.6. The receiver shall comply with all requirements of Section VIII (unfired pressure vessels) of the ASME Boiler and Pressure Vessel Code.
- 2.2.7. The receiver will be factory mounted (unless specified in the drawings) and factory piped.

Specifier: Select the paragraph below, detailing the preferred technology:

For Oil Less (Dry) Contactless Claw Systems

- 2.3. The vacuum pump(s) will be continuous duty, high efficiency, oil less, and frictionless contact-less claw style rotary pumps.
 - 2.3.1. Compact rotary claw positive displacement pumps.
 - 2.3.2. Factory assembled, mounted as a single piped, wired and factory tested package.
 - 2.3.3. Air-cooled with no water requirements, pump chamber must be oil free (no seal or lubricant necessary).
 - 2.3.4. The vacuum pump drive shall be direct driven; torque is transmitted from the flanged motor to the pump through a shaft coupling. The rotors are synchronized by gears.
 - 2.3.4.1. Each motor will be TEFC NEMA C-face. The motors will be suitable for (208V/230V/460V), three phase, 60 Hz.
 - 2.3.5. Each pump will contain: acoustic enclosure, rubber mount vibration isolators, oil sight glass, inlet screen, anti-suck-back valve on inlet, vacuum relief valve (select models), and threaded NPT inlet/outlet connections.
 - 2.3.6. 2.3.6 Each pump will include the following piping control components: flexible inlet and outlet couplings, inlet and outlet shut-off valves, and exhaust drip leg. Each pump exhaust shall be isolated by a union fitting, permitting capping for service removal (if necessary).
 - 2.3.7. Additional accessories including inlet air filters and bacterial filter/fluid traps are not included in standard unit, but available as options.
 - 2.3.8. The maintenance shall be limited to changing the gearbox oil as needed based on the non-contacting design (not more often than 5000 hours and not less frequent than 20,000 hours). Additional maintenance may include replacing the inlet screen as necessary.
 - 2.3.9. V-belt drives will not be acceptable.
 - 2.3.10. Vacuum pumps requiring oil in compression chamber will not be acceptable.

For Oil less (Dry) Rotary Vane System

- 2.3. The vacuum pump(s) will be continuous duty, direct driven, completely dry, air-cooled, positive displacement dry rotary vane style pumps.
 - 2.3.1. Each pump will be equipped with self-lubricating carbon or graphite vanes.
 - 2.3.2. No oil or water is permitted in the pump. No foreign medium is to be used as a lubricating agent.
 - 2.3.3. Bearings must be internally lubricated and sealed.
 - 2.3.4. Each pump will include the following piping control components: flexible inlet and outlet couplings, inlet and outlet shut-off valves, and exhaust drip leg. Each pump exhaust shall be isolated by a union fitting, permitting capping for service removal (if necessary).
 - 2.3.5. Vibration isolation is provided by means of rubber mounts.
 - 2.3.6. The vacuum pump drive shall be directly driven from the motor to the pump through a shaft coupling.
 - 2.3.6.1. Each motor will be TEFC NEMA C-face. The motors will be suitable for (208V/230V/460V), three phase, 60 Hz.
 - 2.3.6.2. Belt drives shall not be permitted.

For Lubricated Rotary Vane System

- 2.3. The medical vacuum pump(s) shall be of rotary vane (dynamically balanced heavy duty multi-vane) air-cooled, positive displacement design with an integral fully recirculating oil supply.
 - 2.3.1. There must be a sight glass to indicate the oil level.
 - 2.3.2. The pump(s) must be capable of removing +99.9% of all oil and smoke particles from the exhaust.
 - 2.3.3. Each pump must be equipped with at least (3) non-asbestos vanes.
 - 2.3.3.1. These vanes must be made of heavy duty aluminum alloys, for maximum heat dissipation.
 - 2.3.3.2. Vane must be check at least every 10,000 operating hours.
 - 2.3.4. Each pump will include the following piping control components: flexible inlet and outlet couplings, inlet shut-off valves, and exhaust drip leg. Each pump exhaust shall be isolated by a union fitting, permitting capping for service removal (if necessary).
 - 2.3.4.1. Rubber hose flex connectors and hose clamps are not acceptable for assembling package.
 - 2.3.5. Vibration isolation is provided by means of rubber mounts.
 - 2.3.6. Pumps that require external piping for oil lubrication will not be accepted.
 - 2.3.6.1. The oil lubrication system must be all enclosed in one complete module for the minimization of any leaks.
 - 2.3.7. The vacuum pump drive shall be directly driven from the motor to the pump through a shaft coupling.
 - 2.3.7.1. Each motor will be TEFC NEMA C-face. The motors will be suitable for (208V/230V/460V), three phase, 60 Hz.
 - 2.3.7.2. Belt drives shall not be permitted.
 - 2.3.7.3. Pumps that require additional electric motors for oil cooling will not be accepted.
 - 2.3.7.4. The maintenance for each pump will include changing the oil as needed (not more often than 500 hours), and replacing the oil separation filter.
 - 2.3.7.4.1. Service to the oil filter(s) shall not require disconnection of the exhaust piping.
- 2.4. Vibration mounting is provided as per NFPA; the pumps and motors will be fully isolated from the package base by means of rubber mounts.
- 2.5. Stainless steel non-braided flexible pipe connections for vacuum inlet connections and resilient mounts to support pump skid.
- 2.6. Provide and mount in vacuum piping –vacuum switch with vacuum gauge and DISS demand check valve; the switch to be wired by others to remote master alarm locations.
 - 2.6.1. The furnished unit will be equipped with the following accessories:

- 2.6.2. Vacuum relief valves, check valves, inlet and discharge flexible connectors, isolation valves, high discharge temperature switches, and vacuum gauges.
- 2.6.3. Factory piped intake with integral flex connector for the intake piping.
- 2.6.4. Additional accessories including inlet air filters, bacterial filter/fluid traps, and tank three-valve bypass are not included in standard unit, but available as options.

SECTION 3 - Compressed Air Equipment for Healthcare Facilities

1 GENERAL

- 1.1. Provide a complete medical air source, complying with NFPA 99 5.1.3.5 in all respects, as specified and scheduled on the drawings.
- 1.2. The complete package will contain (#) (Scroll/Reciprocating) air compressor(s), associated equipment and piping, (1) ASME air receiver, desiccant air dryer package, and (1) control panel. The unit will be able to meet the required demand with (1) compressor out of operation. All capacities are to be indicated in SCFM at necessary pressures.
 - 1.2.1. The air plant will be factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to the intake air.
- 1.3. For maintenance and ventilation of the system, there shall be 2 ft. minimum clearance on all sides, and 3 ft. in front of the control panel.
- 1.4. This furnished and installed unit will be a standard catalog item of the MGEM, who is regularly engaged (minimum five years of experience) in the business of providing packaged systems for hospitals and facilities.
- 1.5. The furnished and installed medical air system will meet or exceed the requirements of NFPA 99's most recent edition as relevant to the equipment; it will be extensively tested before shipment.
- 1.6. The unit will supply medical air continuously for the life of the equipment. All components must be at least duplexed and valved to permit service to any component during maintenance operation or any condition of single fault failure, without interrupting air supply to the facility.
- 1.7. The system will be completely factory assembled, requiring only interconnection between modules on site if necessary (will depend on configuration). Systems requiring site assembly other than interconnection between modules are not acceptable. However, the remounting of components detached for shipping is permitted.
 - 1.7.1. Each module will be sized to fit within the standard 36 in doorway on a standard pallet jack.
- 1.8. The system intake, exhaust, and power connection at the control panel will be the only field (single point) connections required. All components shall be completely pre-piped and pre-wired to single-point service connections.
- 1.9. All interconnecting piping and wiring shall be completed and operationally tested prior to shipment.
- 1.10. Liquid tight conduit, fittings, and junction boxes for all control and power wiring will be provided by the MGEM.
- 1.11. The system shall include individual compressor inline intake filters, discharge check valves, safety relief valves, stainless steel intake and discharge flexible connectors, isolation valves, air cooled

after coolers for each compressor, high discharge temperature shut down switches, pressure control switches, as well as poly tubing for gauge and switches.

1.12. General Requirements for Air Compressors:

- 1.12.1. Comply with NFPA 99, "Health Care Facilities," for compressed-air equipment and accessories for medical compressed-air systems.
- 1.12.2. Mounting Frame: Fabricate base and attachment to air compressor and components with reinforcement strong enough to resist movement during a seismic event when base is anchored to building structure.
- 1.12.3. Each compressor unit shall be equipped with a distinct after cooler with separate cooling fan designed for a maximum approach temperature of 15°F at 100°F ambient.
- 1.12.4. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.
- 1.12.5. A temperature sensor at the outlet of each compressor cylinder or air-end shall provide a high temperature alarm and shutdown that compressor if exceeded. Systems employing a single switch for multiple cylinders or air-ends are not acceptable.

1.13. The compressor modules and motors shall be fully isolated from the main base by means of a four points, heavy-duty isolation system.

1.14. Flexible connections between compressor units and the structure shall be provided for all inlets and outlets.

- 1.14.1. Vibration flexes shall be all stainless steel and of sufficient length to achieve full isolation.
- 1.14.2. Systems using rubber tubing flex connectors with hose clamps are not acceptable.
- 1.14.3. Systems with short flex connections providing only nominal isolation are not acceptable.

Specifier: Adjust number (1.15) below as necessary, when other electrical specs (voltage / phase / frequency) are required.

1.15. The compressor motors must be NEMA rated, open drip proof, 3600 rpm, continuous duty. The motors will be suitable for (208V/230V/460V), three phase, 60 Hz.

2 SYSTEM COMPONENTS

2.1. The control panel and all associated components will be built, labelled, and listed in a UL 508A certified panel shop. It will have a NEMA 12 enclosure, and abide by the following requirements.

2.1.1. Provide in the control cabinet door, the following:

- 2.1.1.1. 16 bit, full color, VGA resolution touch screen display for system functions and system level control. All monitoring must be done on a single screen, multiple screens are not acceptable.
- 2.1.1.2. 320 x 240 p;
- 2.1.1.3. A separate disconnect handle with door interlock for each compressor unit.
- 2.1.1.4. Audio sounder capable of 90 dB at 3 ft., with noise reduction and mute function available on the door.
- 2.1.1.5. LED run indicators on H-O-A switches, indicating which compressor is running.
- 2.1.2. Provide in the control cabinet interior, the following:
 - 2.1.2.1. Externally operable circuit breakers with door interlocks, control circuit transformers with fused primary and secondary circuits, H-O-A switches and magnetic starters with three leg overload protection.
 - 2.1.2.2. Full voltage motor starters with overload protection – one per compressor unit.
 - 2.1.2.3. Alarm contacts must be provided for remote annunciation for all alarm points.
 - 2.1.2.4. Circuit breaker disconnects, one for each compressor unit operated through the door disconnect handle.
 - 2.1.2.5. Controls circuitry shall be 120 Volts AC and 24 Volts DC.
 - 2.1.2.6. Redundant 120 Volts AC control circuit transformers including power seeking function in the event one power supply fails.
 - 2.1.2.7. Power distribution terminal block convenient for main power entry.
 - 2.1.2.8. All internal components needed for operation of the control system as described below.
 - 2.1.2.8.1. Volt free contacts for connection to master alarms.
 - 2.1.2.8.2. No proprietary controls and/or circuitry boards are to be present – all components readily available from local and standard electrical suppliers.
- 2.1.3. The control panel shall provide for the following functions:
 - 2.1.3.1. The reserve compressor(s) must be able to start automatically if the lead compressor fails to operate.
 - 2.1.3.2. Audible and visual local alarms are for compressor temperature malfunction, reserve compressor in use.
 - 2.1.3.3. Display of pressure, dew point and carbon monoxide level on a single 'home' screen display for at-a-glance checking.
 - 2.1.3.4. Digital display of the dew point in °F and CO in ppm on screen.
 - 2.1.3.4.1. The panel will have an audible and visual alarm to indicate if the level of CO exceeds 10 parts per million by volume (ppm).
 - 2.1.3.4.2. The panel will have an audible and visual alarm to indicate if the dew point exceeds 35 °F.

- 2.1.3.4.3. Alarm setting shall be adjustable to allow the system to adapt to any future change in code.
- 2.1.3.5. Automatic lead/lag sequencing and alternation. Display shall clearly show status of each compressor unit including the running unit, next-unit-in-sequence, and units unavailable to run.
- 2.1.3.6. Manual reset for thermal malfunction shutdown.
- 2.1.3.7. Runtime for each compressor unit.
- 2.1.3.8. In the event of control failure the system shall activate all alarms and operate on a simple on/off basis until repaired.
- 2.1.3.9. When H-O-A selectors are in Auto mode, system shall operate on programmable logic controller. Pressure switch shall only be activated as a backup system.
- 2.1.3.10. Controls shall provide visual and audible alarm indication and isolated contacts for remote alarm for at least Dew Point High, CO High, Lag Compressor in Use, and High Temperature for each compressor unit.
- 2.1.3.11. Controls shall provide automatic indication of major maintenance intervals.
- 2.1.3.12. Controls shall provide distinct separate indication on the control screen of alarms related compressor versus alarms related to the system and quality of air.
- 2.1.3.13. Alarm shall be stated on the main screen in plain language of the nature of the alarm. Labeled indication light are not permitted
- 2.1.3.14. Controls shall provide isolated dry contacts for remote alarms required by NFPA 99 Section 5.1.9 related to Medical Air Compressor System
- 2.1.3.15. Dryers shall be controlled from control panel with controls integral to the touchscreen system to allow switching of dryer. External or separate controllers and switches are not acceptable.
 - 2.1.3.15.1. Must be able to cycle automatically between dryer towers
 - 2.1.3.15.2. Dryer purge flow control using an integral dew point based purge control system. Purge controllers using desiccant temperature are not acceptable.
 - 2.1.3.15.3. Both dryers shall be allowed to operate at the same time by overriding dryer select function during maintenance procedures.
 - 2.1.3.15.4. Must be able to indicate dryer operation, status and dew point on same screen.
- 2.1.3.16. Control system shall log and allow review of all alarm and shutdown events.
- 2.1.3.17. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to deliver air or air of quality required. Control systems which can result in inability to deliver air or air of quality required in event of failure of any single component are not acceptable.

- 2.1.3.18. All control and alarm functions must remain energized while any compressor in the system remains electrically online.
- 2.1.3.19. Controls shall include an integral webserver using standard Ethernet allowing observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special or additional separate software are not acceptable.
- 2.1.3.20. Language selection options should include English, French, or Spanish.
- 2.1.3.21. Email alert feature for any and all alarms must be available.
- 2.2. The inlet air filters are to be a combination inlet air filter-silencer, appropriate for remote installation and maintenance for each compressor.
 - 2.2.1. The housing shall be weatherproof with silencer tubes or alternate methods of sound reduction.
 - 2.2.2. The filter elements shall be of a dry paper type, with at least 99% removal efficiency standard to 2 micron.
 - 2.2.3. Each filter must be sized to match the individual capacity of the connected air compressor.
- 2.3. The furnished desiccant dryer package and its associated components will be sized for peak calculated demand, and will have the following requirements:
 - 2.3.1. NFPA99 compliant dual desiccant air dryers with no standalone controller.
 - 2.3.2. There shall be two identical banks of air treatment equipment, piped in parallel and provided with valves to by-pass either filter set for element replacement, maintenance and repair work while still treating medical compressed air through the other set.
 - 2.3.3. Each dryer must be capable of delivering a targeted pressure dew point of -25 °F.
 - 2.3.4. Dew point monitor, CO monitor and system safety valves, as well as dual pre-filters, after filters, and pressure regulators valves will all come standard equipped.
 - 2.3.4.1. Duplexed final line regulators shall be factory mounted and piped at the outlet of each dryer.
 - 2.3.5. Dryers will be completely pre-piped and prewired to single-point service connections.
 - 2.3.6. There shall be two identical banks of air treatment equipment, piped in parallel and provided with valves to by-pass either filter set for element replacement, maintenance and repair work while still treating medical compressed air through the other set.
 - 2.3.7. Each bank must consist of three stages:
 - 2.3.7.1. The 1st stage is a prime efficiency coalescing (pre-filter) rated for 0.01 micron, with filtered differential pressure gauge (element change indicator) and electric solenoid auto drain valve controlled by the main control system, separate controllers are not acceptable.
 - 2.3.7.2. The 2nd stage is a desiccant heatless air dryer.

- 2.3.7.3. The 3rd stage is a prime efficiency particulate after filter rated for 1 micron, with differential pressure gauge (element change indicator).
- 2.3.8. Sensors for dew point and CO sensors shall be provided with a DISS demand check valve per NFPA99 Section 5.1.8.2.4.
- 2.4. The air receiver shall be as follows:
 - 2.4.1. Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2.4.2. Interior Finish: ASME construction of ferrous and/or non-ferrous materials. Corrosion-resistant coating. ASME Boiler and Pressure Vessel Code Section VIII Division 1 construction with two-part epoxy lined coating providing rust protection that is equal to or better than what is normally achieved through galvanizing.
 - 2.4.3. Pressure Rating: Rated for a maximum 200 PSIG MAWP @ 400°F, and full air service, bearing appropriate code symbols.
 - 2.4.4. Accessories: Equipped with pressure gauge, safety relief valve, three valve by-pass, sight (liquid-level) glass, and automatic electronic time based tank drain with manual valve drain override.
 - 2.4.4.1. The three valve by-pass will allow for draining of the receiver without interrupting the air service, as well as isolating the tank for repair maintenance.
 - 2.4.5. The receiver shall comply with all requirements of Section VIII (unfired pressure vessels) of the ASME Boiler and Pressure Vessel Code.
 - 2.4.6. The receiver will be factory mounted (unless specified in the drawings) and factory piped.

Specifier: Select the paragraph below, detailing the preferred technology:

For Scroll Systems

- 2.5. The air compressors will be belt driven oil-less scroll, single stage, continuous duty, air-cooled construction with absolutely no oil needed for operation, and the following requirements:
 - 2.5.1. The compressors should contain (1) fixed and (1) orbiting scroll head, with PTFE seals on the tips between scroll halves.
 - 2.5.2. Absolutely no oil needed for operation. Units requiring re-lubrication are not acceptable.
 - 2.5.3. The compressors will be rated for at least 120 PSIG discharge pressure.
 - 2.5.4. Orbiting bearing and crank pin bearings are to be grease lubricated, with maintenance intervals of 10,000 hours. Units that will require re-lubrication more often will not be accepted.
 - 2.5.5. Compressors will be mounted near motor in such a way that provides easy adjustment of belt tension.
 - 2.5.5.1. For 2-10 HP compressors, belt tensioning shall be achieved with a sliding motor mounting base adjustable with power screw.
 - 2.5.5.2. For 15-20 HP compressors, belt tensioning shall be achieved with a dual sliding compressor mounting base (A-Frame), adjustable with power screw.
 - 2.5.6. Vibration mounting is provided as per NFPA; the compressors and motors will be fully isolated from the package base by means of flexible rubber (neoprene) mounts.
 - 2.5.7. Noise level at 3 ft. shall not exceed 75dB (A) per pump for 10 HP and under and 79dB (A) per pump for 15 HP and above.
 - 2.5.8. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.
 - 2.5.9. Each compressor will be equipped with isolation valve, check valve, safety relief valve, electric motor, belts, belt guard, after cooler, moisture separator, and T.M.P.D. (thermal malfunction protection device).
 - 2.5.9.1. The discharge of piping of each compressor shall incorporate check valve to prevent reverse rotation of the scroll at shutdown.
 - 2.5.10. Compressors shall be field serviceable allowing tip seal change and bearing lubrication. Non-field serviceable scroll compressors are not acceptable.
 - 2.5.11. The standard preventative maintenance shall be limited to replacing the belt(s) as necessary. Scroll tip seals should only be replaced no less than 10,000 hours of operation.

For Reciprocating Systems

- 2.5. The air compressors will be belt driven, single stage, air-cooled, reciprocating style, and the following requirements:
 - 2.5.1. The compressor should be a single stage compressor with 2 or 3 compressing head.
 - 2.5.2. Cylinder shall be guided with PTFE rider band
 - 2.5.3. Absolutely no oil needed for operation.
 - 2.5.4. The compressors will be rated for at least 110 PSIG discharge pressure.
 - 2.5.5. Crankcase ventilation shall be filtered to prevent dust and insects from entering the crankcase.
 - 2.5.6. Compressors will be mounted near motor in such a way that provides easy adjustment of belt tension.
 - 2.5.7. The valve(s) will be corrosion resistant with stainless steel connecting rods.
 - 2.5.8. Noise level at 3 ft. shall not exceed 84dB (A) per pump.
 - 2.5.9. All moving parts (fans, pulleys and belts) shall be fully protected by OSHA acceptable enclosures and guards.
 - 2.5.10. Each compressor will be equipped with isolation valve, check valve, safety valve, electric motor, belts, belt guard, after cooler with separator, and T.M.P.D. (thermal malfunction protection device).
 - 2.5.11. Vibration mounting is provided as per NFPA; the compressors and motors will be fully isolated from the package base by means of spring isolators.
 - 2.5.12. The standard preventative maintenance shall be limited to replacing the belt(s) as necessary. Valve plate and rider band should only be replaced no less than 10,000 hours of operation or three years.